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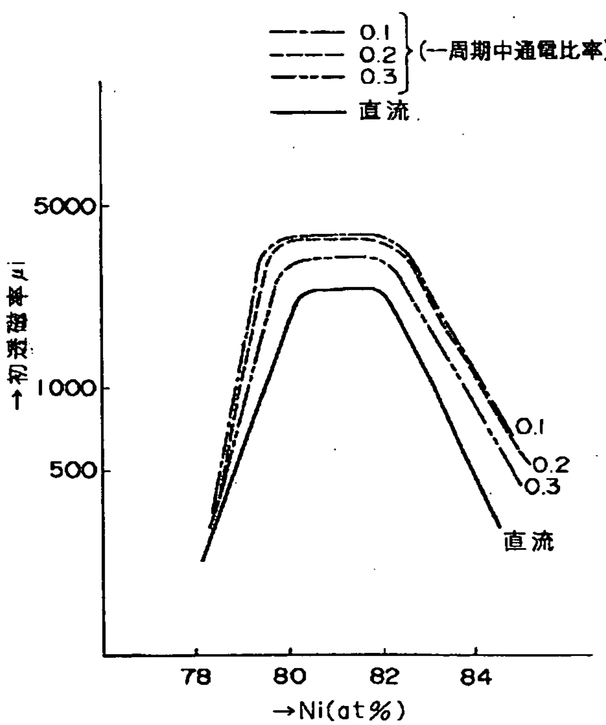
(54)【発明の名称】　薄膜磁気ヘッドおよびその製造方法

(57)【要約】

【構成】　薄膜磁気ヘッドの磁気コアのＮｉ－Ｆｅ合金の形成に用いるメッキ法として、矩形波のパルス電流を用い、そのメッキ電流の通電する時間の１周期にたいする時間の比率が５０％以下の条件をもちいて形成させたことを特徴とした薄膜ヘッドコアの製造方法およびそのコアを用いた薄膜ヘッド。

【効果】　高初透磁率を有した平滑緻密なパーマロイ軟磁性コア薄膜が得られ、出力が高く、ノイズの少ない高信頼性を有する薄膜磁気ヘッドを得ることができ、またメッキレートは通常の直流電流電着の倍以上にすることもできた。また高い透磁率の得られる膜組成の範囲が広いため、組成分布によるＮｉ－Ｆｅ合金薄膜の磁気特性の変動も少なく、出力の高い良好な薄膜磁気ヘッドを安定して製造することができる。



【特許請求の範囲】
【請求項１】下部磁性層と下部磁性層上に磁気ギャップとなる非磁性絶縁層および絶縁層に上下を挟まれて設けられコイルを形成する導体層、上部磁性層、保護膜層を順次構成させた構成を基本とした薄膜磁気ヘッドの電解メッキにより形成されたＮｉ－Ｆｅ合金からなるヘッドコアの製法であって、Ｎｉ－Ｆｅヘッドコア合金のメッキ浴として，Ｎｉの２価イオンに対するＦｅの２価イオンの濃度比率が１／３９から１／２６とし、且つメッキ電流に矩形波の一定周期のパルス電流を用い、メッキ電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合として、

t_{on} / （t_{on}＋t_{off}）≦ 0.5

であることを特徴とする薄膜磁気ヘッドの製造方法。
【請求項２】下部磁性層と下部磁性層上に磁気ギャップとなる非磁性絶縁層および絶縁層に上下を挟まれて設けられコイルを形成する導体層、上部磁性層、保護膜層を順次構成させた構成を基本とした薄膜磁気ヘッドであって、電解メッキにより形成されたＮｉ－Ｆｅ合金からなるヘッドコアを有し、前記Ｎｉ－Ｆｅ合金がメッキ浴として、Ｎｉの２価イオンに対するＦｅの２価イオンの濃度比率が１／３９から１／２６で、且つメッキ電流に矩形波の一定周期のパルス電流を用い、メッキ電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合として、

t_{on} / （t_{on}＋t_{off}）≦ 0.5

で成膜されたものであることを特徴とする薄膜磁気ヘッド。
【請求項３】Ｎｉの２価イオンに対するＦｅの２価イオンの濃度比率が１／３９から１／２６であるメッキ浴を用い、パルス電流の周波数が１ｋＨｚ以下であり、且つメッキ電流に矩形波の一定周期のパルス電流を用い、メッキ電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合が、

t_{on} / （t_{on}＋t_{off}）≦ 0.5

であることを特徴とするＮｉ－Ｆｅ合金膜の製造方法。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明はコンピューターのＨＤＤ装置等に用いられる薄膜磁気ヘッドおよびその製造方法に関わるものである。
【０００２】
【従来の技術】ハードディスクドライブ（ＨＤＤ）装置の記憶容量の大型化の要求から、高密度磁気記録の要望とこれに加えてヘッドについては高出力化とともにノイズ等にたいする高信頼性を持ったものであることが要求されている。そのために、電着法で作製される従来のパーマロイ磁気コア膜についても、さらに高透磁率化や、欠陥の少ない平滑膜化が必要となっている。従来の直流電着技術においては、メッキ浴中に界面活性剤や応力緩和促進剤などを添加させることでそれぞれ電着膜の平滑緻密化や内部応力の除去を進める事でパーマロイ磁気コアの軟磁気特性の改善が試みられてきた。
【０００３】
【発明が解決しようとする課題】しかしながら従来の直流電着法によるＮｉ－Ｆｅ合金（パーマロイ合金）メッキコアでは電着膜の初透磁率が3000程度が上限であり、またしばしば水素発泡による気泡の取り込みや、ヘッドコアパターン内での異常成長などマクロな電着膜の欠陥等が発生し、これによる素子の製造歩留まりの低下や、ヘッド出力の劣化、磁壁の拘束によるノイズの発生などの課題があった。
【０００４】
【課題を解決するための手段】上記の課題を改善した高性能な薄膜磁気ヘッドおよびそのヘッドコアの製造方法として本発明の薄膜磁気ヘッドおよびその製造方法では、Ｎｉ－Ｆｅヘッドコア合金のメッキ浴に，Ｎｉの２価イオンに対するＦｅの２価イオンの濃度比率が１／３９から１／２６のものを用い、且つ（図３）に示したようにメッキ電流に矩形波の一定周期のパルス電流を用い、メッキ電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合として、

t_{on} / （t_{on}＋t_{off}）≦ 0.5

で成膜された軟磁性膜コアを磁気ヘッドとして採用するものである。
【０００５】
【作用】直流電流による電着ではカソード近傍のNi^{2+},やFe^{2+}の陽イオンの放電による消費が拡散による供給をうわまわるため通常はカソード近傍のイオン濃度やpHは浴全体のものと大きく異なり、この電着合金イオンの供給がメッキ膜の合金組成や結晶面配向成膜状態等にも強く関わる。しかし、パルス電流をメッキ電流に用いることにより（図３）に示すように、電流の通電状態と通電停止状態ができ、この通電停止状態でカソード近傍のイオンの補充が行なわれ易くなり、同一のメッキ浴を用いたとしても通常の直流メッキによる電着膜とは合金組成、結晶面配向、応力状態等異なった状態で成膜される。
【０００６】また、カソード近傍のイオン濃度は大きく低下しないことから、通電時の電流密度を上げることもでき、メッキレートを向上させることもできることになる。さらに連続放電と場合と比べてＮｉ－Ｆｅ合金薄膜に取り込まれる不純物も少なくなり磁気コアの透磁率特性などの磁気特性も向上する。
【０００７】
【実施例】本発明の実施例を以下に示す。本発明は（図１）に示すような薄膜構成を基本とする薄膜磁気ヘッドの磁気コア膜の製法に関する。即ち、基板１上に下部磁性層２と下部磁性層２上に磁気ギャップとなる非磁性絶縁層３およびコイル絶縁層４に上下を挟まれて設けら

れ、コイルを形成する導体コイル層５、上部磁性層７、保護膜８を順次構成してインダクティブ薄膜磁気ヘッドとした。基本的には（図１）の薄膜構成を記録ヘッドの基本として用いた各種磁気抵抗型ヘッドでも同様な効果が期待できる。

【０００８】磁気コア層のメッキ浴としては（表１）に示す様な硫酸浴系を中心とした浴を用いた。

【０００９】

【表１】

浴1	$NiSO_4 \cdot 6H_2O$	370 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/26
	$NiCl_2 \cdot 6H_2O$	35 g/l	
	$FeSO_4 \cdot 7H_2O$	13 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	1.5 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.25 g/l	
	温度	40 ℃	
	ｐＨ	2.3	
浴2	$NiSO_4 \cdot 6H_2O$	290 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/39
	$NiCl_2 \cdot 6H_2O$	35 g/l	
	$FeSO_4 \cdot 7H_2O$	9 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	1.8 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.25 g/l	
	温度	40 ℃	
	ｐＨ	2.2	
浴3	$NiSO_4 \cdot 6H_2O$	240 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/29
	$NiCl_2 \cdot 6H_2O$	30 g/l	
	$FeSO_4 \cdot 7H_2O$	10 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	2.0 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.2 g/l	
	温度	40 ℃	
	ｐＨ	2.2	
浴4	$NiSO_4 \cdot 6H_2O$	350 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/32
	$NiCl_2 \cdot 6H_2O$	10 g/l	
	$FeSO_4 \cdot 7H_2O$	12 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	2.0 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.2 g/l	
	温度	40 ℃	
	ｐＨ	2.2	

【００１０】（図２）はメッキ電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合として、0.1、 0.2、 0.3、 0.5 を採用した場合の（即ち５分の１ 周期の On-Time）成膜された電着膜の合金組成（原子％）と初透磁率（１ＭＨｚ値）の関係を示したものである。いずれもメッキ浴としては（表１）の浴１を用いた。ﾒｯｷ電流密度としてはいずれも50mA/cm²(ピーク高さ値)で１０Ｈｚの矩形波をもちいた。

【００１１】実線が従来の直流電着成膜によるＮｉ－Ｆｅ合金膜の特性、破線が本発明によるところの上記（表１）のメッキ浴を用い、パルスめっき電流を流す時間（t_{on}）とメッキ電流を流さない時間（t_{off}）の割合

として、$t_{on}/(t_{on}+t_{off})=0.2$ で成膜されたものである。

【００１２】従来の直流電着のＮｉ－Ｆｅ膜と比較して本発明のパルス電着によるヘッドコア用薄膜においてはより高い初透磁率がより幅広い合金組成範囲でえられることがわかった。同様に（図２）中の一点鎖線、二点鎖線はそれぞれ0.1、 0.3 の周期に対する通電時間比率によって成膜した電着膜の特性を示すものである。また、0.5のものについては実線の直流めっきの結果とわずかに有意差をもって高透磁率をしめす範囲が広がったが0.5をうわまわるの電着膜については初透磁率の合金組成依存性は（図２）実線の直流電着のものと一致し、とくにパルスメッキを採用した効果はなかった。電着膜の結晶配向性を調べた結果では直流電着膜から通電比率0.5までのパルス電着膜ではほぼ同じ優先面配向性（(111)面配向、および(100)面配向の両者が混在）を示したのに対して、0.5以下の比率のパルス電着膜ではやや(111)面の優先面配向の進んだ構造が確認された。

【００１３】（図２）の0.5以下の通電比率の本発明の独自性はこれに対応して現れた。またさらに（図２）の通電時間比率 0.5以下の直流電着膜との優位性は浴２、および浴３、４をもちいて（図２）と同様に合金組成を調整させてえた電着膜についても確認できた。（表１）の浴１から浴４までのメッキ浴のＮｉの２価イオンにたいするＦｅの２価イオンの濃度比率は（表１）中にも記した様に１／３９から　１／２６の範囲に相当する。

【００１４】（図４）は、通電比率を0.2として作製した膜を使用し、（表２）の仕様の薄膜インダクティブヘッドを作製して評価した入出力特性（ａ）を、従来の電着膜を使用して作製した同一仕様のヘッドの入出力特性（ｂ）と比較したものである。

【００１５】

【表２】

磁気ギャップ長	0.5 μm	記録媒体	Co-Ni
記録電流	60 mA	媒体速度	10 m/s
最高周波数	18 MHz	媒体抗磁力	1500 Oe
最低周波数	4.5 MHz	ﾃﾞｨｽｸ回転数	3600 rpm
浮上量	0.15 μm	コイル巻数	32

【００１６】（図２）で示したように初透磁率特性が向上したことに対応して（ｂ）の（表２）と同仕様ヘッドの同一条件で評価した場合にくらべて、ヘッドの高出力化が確認された。

【００１７】

【発明の効果】本発明を用いれば、高初透磁率を有した平滑緻密なパーマロイ軟磁性コア薄膜が得られ、出力が高く、ノイズの少ない高信頼性を有する薄膜磁気ヘッドを得ることができ、またメッキレートは通常の直流電流電着の倍以上にすることもできた。

【００１８】十分な磁気ヘッドの特性を得るために必要な初透磁率が１０００以上の良好なＮｉ－Ｆｅ合金薄膜が得られる膜組成の範囲が広いため、組成分布によるＮｉ－Ｆｅ合金薄膜の磁気特性の変動も少なく、出力の高い良好な薄膜磁気ヘッドを安定して製造することができる。

【図面の簡単な説明】

【図１】本発明を応用させたの薄膜ヘッドの構成図

【図２】膜組成と初透磁率の関係を示すグラフ

【図３】本発明に用いるパルスメッキ電流の１周期の矩形波形図

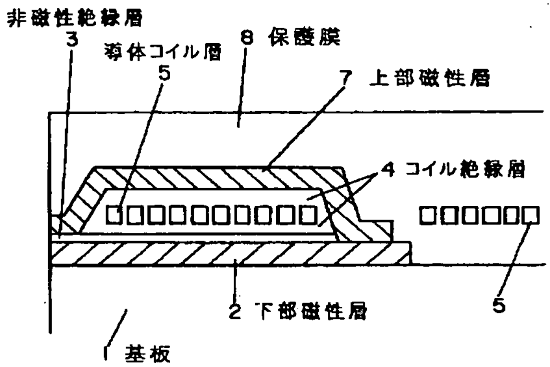
【図４】（ａ）は本発明による薄膜磁気ヘッドの入出力特性を示す図

（ｂ）は同じ仕様の従来ヘッドの入出力特性を示す図

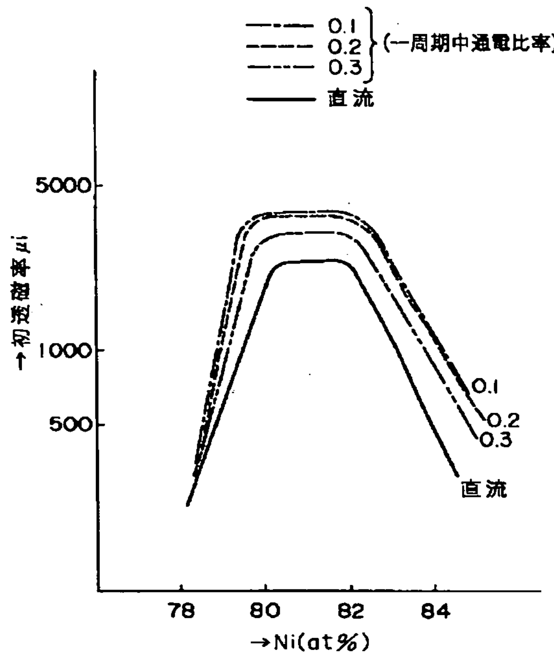
【符号の説明】

1　基板
2　下部磁性層
3　非磁性絶縁層
4　コイル絶縁層
5　導体コイル層
7　上部磁性層
8　保護膜

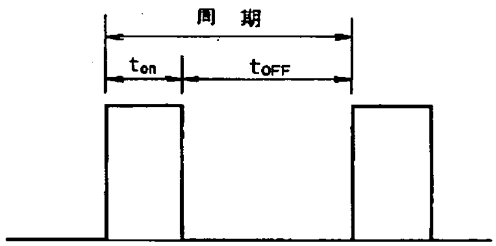
【図1】


非磁性絶縁層
3
導体コイル層
5
8 保護膜
7 上部磁性層
4 コイル絶縁層
5
2 下部磁性層
1 基板

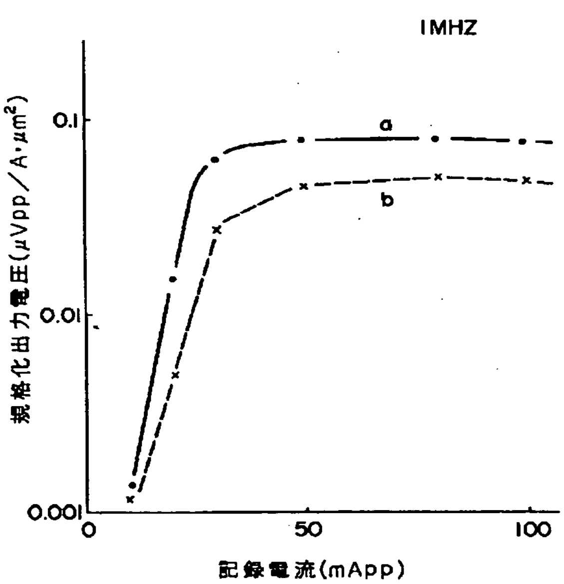
【図2】


0.1
0.2
0.3
(一周期中通電比率)
直流
→初透磁率μi
5000
1000
500
0.1
0.2
0.3
直流
78
80
82
84
→Ni(at%)

【図3】


周 期
ton
tOFF

【図4】


IMHZ
規格化出力電圧(μVpp/A・μm²)
0.1
0.01
0.001
a
b
0
50
100
記録電流(mApp)

PATENT ABSTRACTS OF JAPAN

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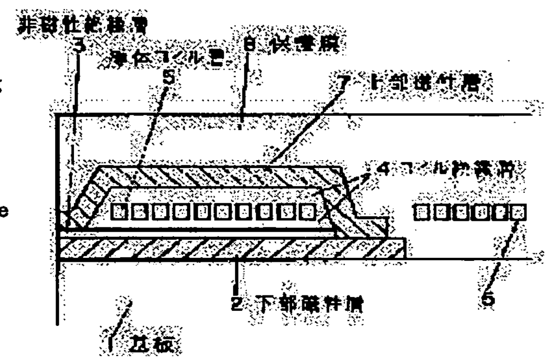
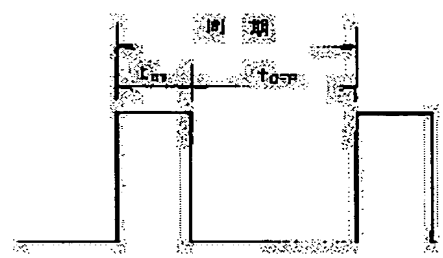
(54) THIN-FILM MAGNETIC HEAD AND ITS MANUFACTURE

(57)Abstract:
PURPOSE: To obtain a smooth and compact permalloy soft magnetic core having a high initial permeability, at the time of attaching Ni-Fe alloy to the magnetic core of a thin-film magnetic head with the use of plating, by using a rectangular-wave pulse current to specify the ratio of time to one period of the application time of electric current.
CONSTITUTION: On a substrate 1, a lower magnetic film 2, non-magnetic insulating layer 3 being a magnetic gap, conductor coil layer 5 surrounded by a coil insulating layer 4, upper magnetic layer 7 and protective coat 8 are successively constituted into an inductive thin-film magnetic head. Then, plating is applied to a magnetic core layer constituting the head. A plating film is formed while a plating current has a density of 50mA/cm2 in peak height value and the ratio of time ton, during which the plating current is caused to flow, to time toff, during which the current is not caused to flow, is set at ton/(ton+toff)=0.2. Thus, a rate of plating can also be increased twice as much as that of an ordinary DC electrodeposition or higher.





LEGAL STATUS

[Date of request for examination]	13.10.1998
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CLAIMS

[Claim(s)]
[Claim 1] The conductor layer which the upper and lower sides are sandwiched by the nonmagnetic insulating layer and insulating layer used as a magnetic gap, is prepared on a lower magnetic layer and a lower magnetic layer at them, and forms a coil, It is the process of the head core which consists of a nickel-Fe alloy formed of the electrolytic plating of the thin film magnetic head based on the configuration which carried out the sequential configuration of an up magnetic layer and the protective coat layer. As a plating bath of a nickel-Fe head core alloy The rate of the ratio of concentration of the divalent ion of Fe to the divalent ion of nickel sets to 1/39 to 1/26. And the manufacture approach of the thin film magnetic head which the pulse current of the fixed period of a square wave is used for a plating current, and the time amount (ton) which passes a plating current, and the time amount (toff) which does not pass a plating current carry out comparatively, and is characterized by being ton / <= (ton+toff) 0.5.

[Claim 2] The conductor layer which the upper and lower sides are sandwiched by the nonmagnetic insulating layer and insulating layer used as a magnetic gap, is prepared on a lower magnetic layer and a lower magnetic layer at them, and forms a coil, It has the head core which consists of a nickel-Fe alloy which is the thin film magnetic head based on the configuration which carried out the sequential configuration of an up magnetic layer and the protective coat layer, and was formed of electrolytic plating. Said nickel-Fe alloy as a plating bath The rate of the ratio of concentration of the divalent ion of Fe to the divalent ion of nickel by 1/39 to 1/26 And the thin film magnetic head which the pulse current of the fixed period of a square wave is used for a plating current, and the time amount (ton) which passes a plating current, and the time amount (toff) which does not pass a plating current carry out comparatively, and is characterized by forming membranes by ton / <= (ton+toff) 0.5.
[Claim 3] The manufacture approach of the nickel-Fe alloy film characterized by being [of the time amount (ton) which the frequency of pulse current is 1kHz or less, and uses the pulse current of the fixed period of a square wave for a plating current, and passes a plating current, and the time amount (toff) which does not pass a plating current] ton / <= (ton+toff) 0.5 comparatively using the plating bath whose rate of the ratio of concentration of the divalent ion of Fe to the divalent ion of nickel is 1/39 to 1/26.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is concerned with the thin film magnetic head used for the HDD equipment of a computer etc., and its manufacture approach.
[0002]
[Description of the Prior Art] In addition to a request and this of high density magnetic recording, from the demand of enlargement of the storage capacity of hard disk drive (HDD) equipment, it is required about the head that it should have the high-reliability over noise ** etc. with a high increase in power. Therefore, a raise in permeability and smooth film-ization with few defects are further needed also about the conventional permalloy magnetic-core film produced with an electrodeposition process. In the conventional direct-current electrodeposition technique, the improvement of the soft magnetic characteristics of a permalloy magnetic core has been tried by advancing smooth eburnation of an electrodeposited film, and removal of internal stress by making a surfactant, a stress relaxation accelerator, etc. add during a plating bath, respectively.
[0003]
[Problem(s) to be Solved by the Invention] However, with the nickel-Fe alloy (permalloy alloy) plating core by the conventional direct current electrodeposition process, the initial permeability of an electrodeposited film be [about 3000] an upper limit, and the defect of macroscopic electrodeposited films, such as incorporation of the air bubbles by hydrogen foaming and abnormality growth within a head core pattern, etc. often occurred, and technical problems, such as a fall of the manufacture yield of the component by this, and degradation of a head output, generating of the noise by constraint of a magnetic domain wall, occurred.
[0004]
[Means for Solving the Problem] As the manufacture approach of the highly efficient thin film magnetic head which has improved the above-mentioned technical problem, and its head core, by the thin film magnetic head and its manufacture approach of this invention The rate of the ratio of concentration of the divalent ion of Fe to the divalent ion of nickel uses the thing of 1/39 to 1/26 for the plating bath of a nickel-Fe head core alloy. And (drawing 3) as shown, use the pulse current of the fixed period of a square wave for a plating current, and the time amount (ton) which passes a plating current, and the time amount (toff) which does not pass a plating current carry out comparatively. The soft magnetism film core formed by ton / <= (ton+toff) 0.5 is adopted as the magnetic head.
[0005]
[Function] In electrodeposition by the direct current, in supply according [consumption by discharge of the cation of nickel2+ near the cathode and ** Fe2+] to diffusion, a ********** sake, the ion concentration and pH near the cathode differ from the thing of the whole bath greatly, and supply of this electrodeposted alloy ion is usually strongly concerned in the alloy presentation of the plating film, the crystal-face orientation membrane formation condition, etc. However, as by using for a plating current shows pulse current to (drawing 3), even if the energization condition and energization idle state of a current are made, a supplement of the ion near the cathode becomes is easy to be performed by this energization idle state and it uses the same plating bath, the electrodeposited film by the usual direct-current plating is formed after an alloy presentation and crystal-face orientation have differed from the stress condition etc.
[0006] Moreover, since the ion concentration near the cathode does not fall greatly, it can also raise the current density at the time of energization, and can also make MEKKIRE-TO improve. The impurity furthermore incorporated by the nickel-Fe alloy thin film compared with continuous discharge and a case also decreases, and magnetic properties, such as the permeability property of a magnetic core, also improve.
[0007]
[Example] The example of this invention is shown below. This invention relates to the process of the magnetic-core film of the thin film magnetic head based on a thin film configuration as shown in (drawing 1). namely, the conductor which the upper and lower sides are sandwiched by the nonmagnetic insulating layer 3 and the coil insulation layer 4 which serve as a magnetic gap on the lower magnetic layer 2 and the lower magnetic layer 2, is prepared in them, and forms a coil on a substrate 1 — the sequential configuration of the coil layer 5, the up magnetic layer 7, and the protective coat 8 was carried out, and it considered as the inductive thin film magnetic head. The same effectiveness is expectable also with the various magnetic-reluctance mold heads using the thin film configuration of being fundamental (drawing 1) as a base of a recording head.
[0008] The bath centering on a sulfuric-acid bath system as shown in (Table 1) as a plating bath of a magnetic-core layer was used.
[0009]
[Table 1]

浴 1	$NiSO_4 \cdot 6H_2O$	370 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/26
	$NiCl_2 \cdot 6H_2O$	35 g/l	
	$FeSO_4 \cdot 7H_2O$	13 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	1.5 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.25 g/l	
	温度	40 ℃	
	pH	2.3	
浴 2	$NiSO_4 \cdot 6H_2O$	290 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/39
	$NiCl_2 \cdot 6H_2O$	35 g/l	
	$FeSO_4 \cdot 7H_2O$	9 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	1.8 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.25 g/l	
	温度	40 ℃	
	pH	2.2	
浴 3	$NiSO_4 \cdot 6H_2O$	240 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/29
	$NiCl_2 \cdot 6H_2O$	30 g/l	
	$FeSO_4 \cdot 7H_2O$	10 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	2.0 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.2 g/l	
	温度	40 ℃	
	pH	2.2	
浴 4	$NiSO_4 \cdot 6H_2O$	350 g/l	$[Fe^{2+}]/[Ni^{2+}]$ = 1/32
	$NiCl_2 \cdot 6H_2O$	10 g/l	
	$FeSO_4 \cdot 7H_2O$	12 g/l	
	H_3BO_3	40 g/l	
	ｻｯｶﾘﾝ酸ﾅﾄﾘｳﾑ	2.0 g/l	
	ﾗｳﾘﾙ硫酸ﾅﾄﾘｳﾑ	0.2 g/l	
	温度	40 ℃	
	pH	2.2	

[0010] The time amount (ton) which passes a plating current, and the time amount (toff) which does not pass a plating current carry out comparatively, and (drawing 2) is 0.1, 0.2, 0.3, and 0.5. The relation between the alloy presentation (atomic %) of an electrodeposited film and initial permeability (1MHz value) by which membranes were formed at the time of adopting (namely, 1/5 On-Time of a period) is shown. All used the bath 1 of (Table 1) as a plating bath. As plating current density, each was with the 10Hz square wave by 50 mA/cm2 (peak height value).
[0011] The time amount (ton) which passes a pulse plating current, and the time amount (toff) which does not pass a plating current carry out comparatively using the plating bath of the above (Table 1) of the place which the property of the nickel-Fe alloy film by direct-current electrodeposition membrane formation of the former [continuous line] and a broken line depend on this invention, and it is ton / = (ton+toff) 0.2. Membranes are formed.
[0012] It turned out that higher initial permeability is obtained in the broader alloy presentation range in the thin film for head cores by pulse electrodeposition of this invention as compared with the nickel-Fe film of the conventional direct-current electrodeposition. An inner alternate long and short dash line and a two-dot chain line are 0.1 and 0.3 similarly (drawing 2), respectively. The property of the electrodeposited film which formed membranes with the resistance-welding-time ratio to a period is shown. Moreover, although the range which indicates high permeability slightly to be the result of direct-current plating of a continuous line with a significant difference about the thing of 0.5 spread, about the electrodeposited film of **********,

there was especially no effectiveness as which the alloy presentation dependency of initial permeability adopted pulse plating in accordance with the thing of direct-current electrodeposition of a continuous line (drawing 2) about 0.5. At the result of having investigated the crystal stacking tendency of an electrodeposited film, the structure to which the priority plane orientation of a field progressed a little (111) was checked by the pulse electrodeposited film of 0.5 or less ratio to the almost same priority plane orientation nature (111) (both plane orientation and (100) plane orientation being intermingled) having been shown by the pulse electrodeposited film from the direct-current electrodeposited film to the energization ratio 0.5.
[0013] The peculiarity of this invention of 0.5 or less energization ratio of (drawing 2) appeared corresponding to this. furthermore (drawing 2), resistance-welding-time ratio a predominance with 0.5 or less direct-current electrodeposited film -- a bath 2 and baths 3 and 4 -- having -- it is (drawing 2) -- it has checked also about the electrodeposited film which was made to adjust an alloy presentation similarly and was obtained. The rate of the ratio of concentration of the divalent ion of Fe to the divalent ion of nickel of the plating bath from the bath 1 of (Table 1) to a bath 4 is from 1/39 to the appearance described also in Table 1 Inside. It is equivalent to 1/26 of range.
[0014] (Drawing 4) uses the film which produced the energization ratio as 0.2, and compares with the input-output behavioral characteristics (b) of the head of the same specification which produced the input-output behavioral characteristics (a) which produced and evaluated the thin film inductive head of the specification of (Table 2) using the conventional electrodeposited film.

[0015]
[Table 2]

磁気ギャップ長	0.5 μm	記録媒体	Co-Ni
記録電流	60 mA	媒体速度	10 m/s
最高周波数	18 MHz	媒体抗磁力	1500 Oe
最低周波数	4.5 MHz	ディスク回転数	3600 rpm
浮上量	0.15 μm	コイル巻数	32

[0016] The high increase in power of a head was checked compared with the case where the same conditions of the (Table 2) and this specification head of (b) estimate corresponding to the initial permeability property having improved as (drawing 2) showed.
[0017]
[Effect of the Invention] When using this invention, the smooth precise permalloy soft magnetism core thin film with high initial permeability was obtained, the output could be high, and the thin film magnetic head which has high-reliability with few noises could be obtained, and the plating rate was also able to be carried out more than [of the usual direct-current electrodeposition] twice.
[0018] Since the range of a film presentation where 1000 or more good nickel-Fe alloy thin films are obtained for initial permeability required in order to acquire the property of sufficient magnetic head is wide, there is also little fluctuation of the magnetic properties of the nickel-Fe alloy thin film by presentation distribution, it is stabilized and the good thin film magnetic head with a high output can be manufactured.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram of a making [apply]-this invention thin film head
[Drawing 2] The graph which shows the relation between a film presentation and initial permeability
[Drawing 3] The square wave form Fig. of one period of a pulse plating current used for this invention
[Drawing 4] (a) is drawing showing the input-output behavioral characteristics of the thin film magnetic head by this invention.
(b) is drawing showing the input-output behavioral characteristics of the conventional head of the same specification.
[Description of Notations]
1 Substrate
2 Lower Magnetic Layer
3 Nonmagnetic Insulating Layer
4 Coil Insulation Layer
5 Conductor — Coil Layer
7 Up Magnetic Layer
8 Protective Coat

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* NOTICES *

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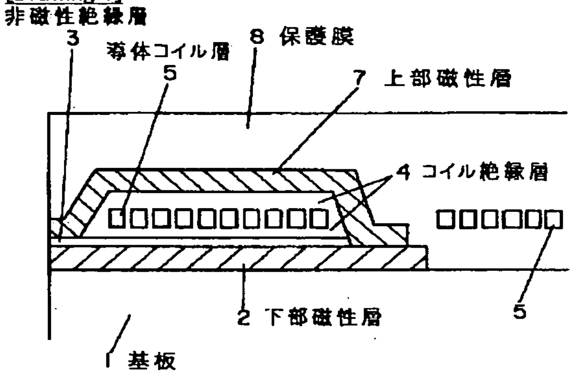
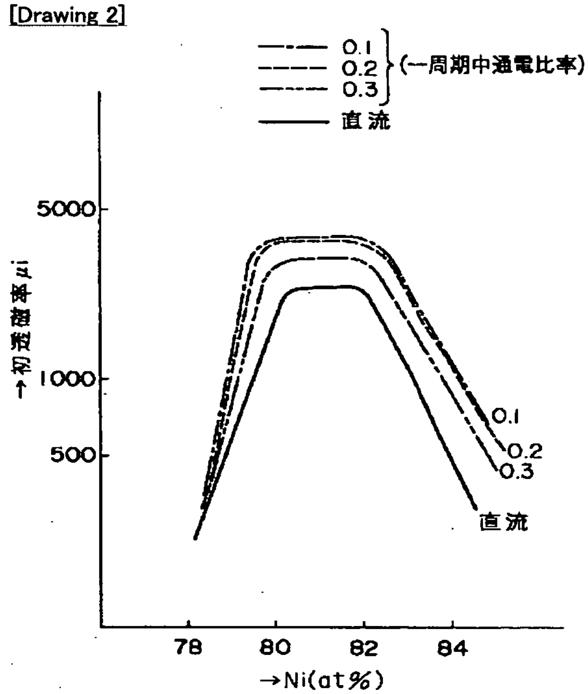
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

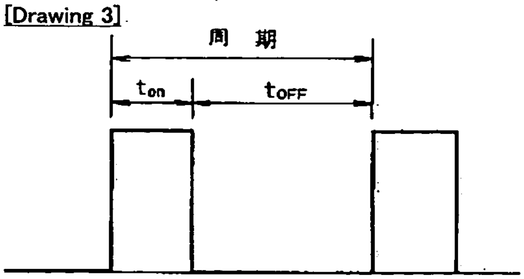
[Drawing 1]



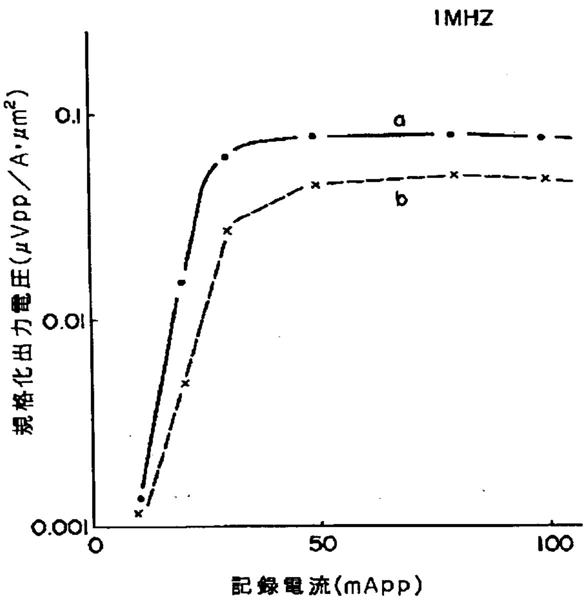
[Drawing 2]



[Drawing 3]



[Drawing 4]



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